WD8BKE

BK – 0
BN – 1
R – 2
O – 3
Y – 4
G – 5
BL – 6
V – 7
G – 8
W – 9

22K = RRO

.3K =

3.3K =
33000

PARTS LIST -- TWS-10 -- DIGIDIAL ADAPTOR

Resistors (All values in ohm)

$ .15 ea.

R4, R12, R20, R21	=	150	R5 = not needed
R3, R10	=	1 k	R11 = 390 ohm
R7, R19	=	2.2 k	
R6	=	3.3 k	
R16, R18	=	6.8 k	
R9	=	15 k	
R8, R17	=	39 k	
R13, R15	=	150 k	
R22	=	680	
R1, R2, R14	=	22 k ONLY ONE	

Capacitors

C2, C12, C17	=	.01 uf (35 pf supplied)	$ .50 ea.
C1, C3, C7, C8, C10	=	30 pf	$ .80 ea.
C11, C13	=	130 pf; (120 pf supplied)	$ .30 ea.
C16	=	100 pf	$ .30 ea.
C14, C9	=	.1 uf	$ .50 ea.
C4	=	.001 uf	$ .75 ea.
C15	=	1000 uf	$2.00 ea.
C5, C6	=	2.3-22 pf trimmer	$2.00 ea.
C18	=	35 pf	

Coils

L1, L3, L4	=	68 uh	$ .50 ea.
L2	=	43 uh	$ .50 ea.

Semiconductors

(2N4400 supplied)

Q1, Q2, Q3, Q5, Q6	=	2N3904 or equivalent	$1.00 ea.
Q4	=	RCA 40673	$3.50 ea.
D1, D2	=	1N4001 or equiv.	$ .50 ea.

1N4002 SUPPLIED

Misc.

(1)	Mini DPDT Switch	$ .50 ea.
(1)	7500 kHz Crystal	$5.00 ea.
(1)	PC Board	$9.95 ea.

Price, Ppd, U.S.A.

ERRATA

Corrections

Q4 next to Q5 should read Q6 on the PC Board.

Additions

To facilitate checkout, we've added the following information on wave forms (be sure your scope has the proper band width and the probe has a high input impedence):

Base of Q2:	Sine wave, approximately 2V pp.
Pin 2 of Q4:	"Mixed" wave form, approximately 2V pp.
Pin 3 of Q4:	Clipped sine wave of approximately 7.5 mhz, 2V pp, and should not change more than .4V pp amplitude when S1 is switched from USB to LSB
Pin 4 of Q4:	"Mixed" wave form, approximately .15V pp
Collector of Q6:	Approximate an inverted sine wave, 2.5V pp (2 - 2.5 mhz)
Emitter of Q5:	Same as above, 1.5 - 2.0V pp (2 - 2.5 mhz)

Tune-Up Notes

We suggest that you use the calibrator in your set when adjusting the oscillator in the TWS-10. This may require alignment of your transceiver, as we've found that if the set is not aligned properly, the marker signal zero beat will appear in a different spot for each band, thus requiring frequent adjustment of the TWS-10 oscillator.

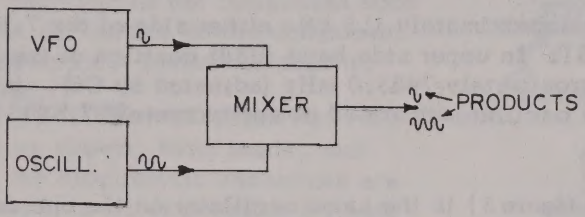
Put SW1 in the LSB position. Set C5 to 1/3 full mesh. Now find the band on which the marker zeros and the counter reads the proper mhz frequency. You should then align your set and Adaptor from this point.

If the set has no calibrator, then follow the procedure outlined in the text.

IDEA BEHIND THE ADAPTOR

The need for the adaptor has been established by the recent number of transceivers appearing on the market which have reverse tuning VFO's, and those whose owners require a digital readout. Direct reading on the counter from the VFO is highly impractical, and therefore a device is needed to turn the VFO's output "upside-down" to something readable to the counter and meaningful to its operator.

This is accomplished with a process known as heterodyning, or simply electrically mixing two frequencies to obtain a desirable product. The flow chart shows how this works:

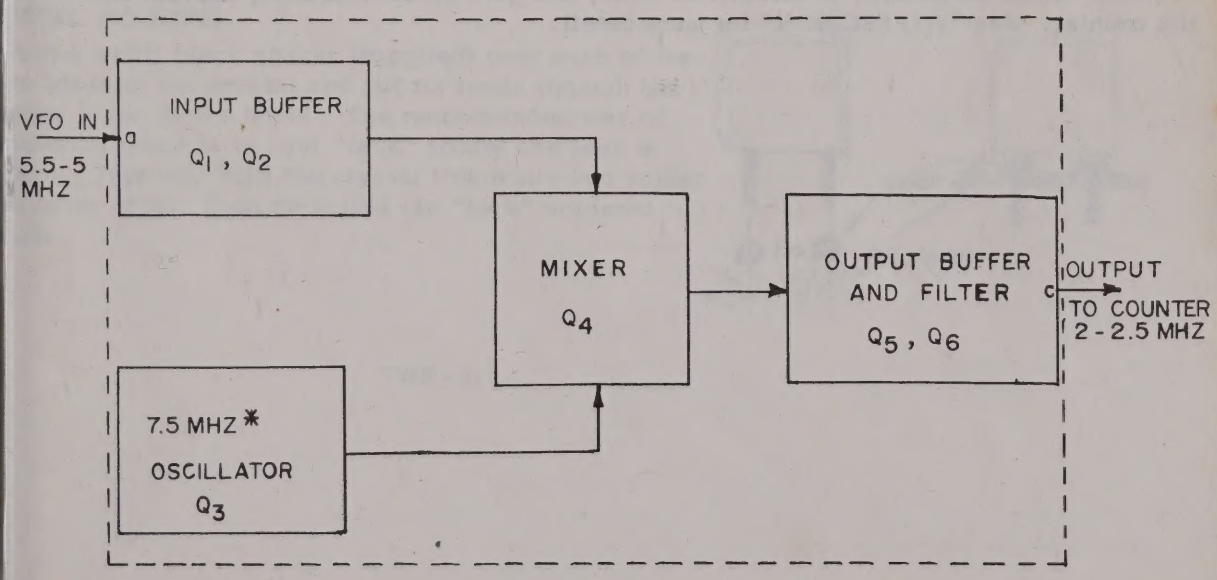


The particular product we are interested in is the one that give us a readout comparable to that of the transceiver, and reverse of the VFO. If we use the product that results from the subtraction of one frequency from another, and establish one as the VFO frequency, and the other as 7.5 mHz, then the output would be as follows:

7.5 mHz - 5.5 mHz = 2.0 mHz (low end of band)
7.5 mHz - 5.0 mHz = 2.5 mHz (high end of band)

Notice that as the VFO tuned from 5.5 to 5 mHz, the output went from 2.0 to 2.5 mHz. By ignoring the "2", we would have the required 0 to 500 kHz reading we desire.

BLOCK DIAGRAM OF DIGI-DIAL ADAPTOR TWS-10



* = See Text

HOW IT WORKS

The 5.5 to 5 mHz VFO signal is fed to the Input Buffer consisting mainly of Q1 and Q2. This section serves to isolate the transceiver VFO circuitry from the adaptor and counter, amplify the VFO signal if needed, and give a constant level to the mixer.

The 7.5 mHz oscillator produces a sine wave of approximately 7.5000 mHz*. We say approximately because the standard version of the adaptor uses a VXO (variable crystal oscillator) circuit design. This is so that the oscillator may be tuned and yet retain the high stability of a crystal design.

The oscillator is switched to approximately 1.5 kHz either side of the 7.5000 mHz center frequency via switch S1. In upper side band (USB) position of the switch, the oscillator is operating at approximately 7485.0 mHz (adjusted by C6). in the lower side band position (LSB), the oscillator operated at approximately 7.5015 mHz (adjusted by C5).

The Modified Oscillator (see figure 5) is the same oscillator as the one described above with the S1 in the USB position. The only differences are that jumper J1 replaces the switch, C5 is used in place of C6, and the oscillator is tuned to 7.5000 mHz.

The signals from the input buffer and the oscillator are then fed to the mixer, Q4. This unit mixes the two frequencies and sends their products to the filters and output buffers. One of the products is the frequency range between 2 and 2.5 mHz.

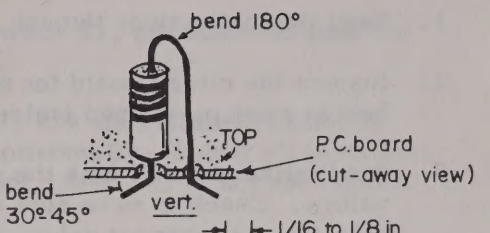
The output buffers and filters are set up to not pass any frequency above or below the 2 to 2.5 mHz range. Q5 and Q6 amplify these frequencies and supply a low-impedence signal to the frequency counter.

Because of the inherent frequency shift when switching from USB to LSB operation, the oscillator is set to operate at 1.5 kHz higher or lower (depending on whether youre operating the tranceiver in lower side band or upper side band respectively) than the 7.5 mHz center frequency, to offset this shift, and give actual frequency readout on the counter. See "VFO SECTION" for more detail.

COMPONENT MOUNTING GUIDELINES

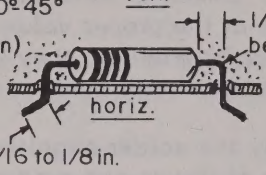
VERTICAL MOUNTING – RESISTORS, CAPACITORS (resistor shown)

Bend one lead back down along side the component body so that both leads are going the same direction. Insert component, bend leads to 30°-45° angle, and solder.



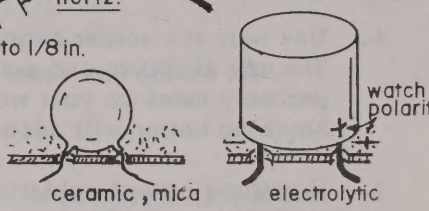
HORIZONTAL MOUNTING – RESISTORS, CAPACITORS (resistor shown)

Go about 1/8" from each end of the component body and bend the leads at 90° angles to the component body, in the same direction. Insert component, bend leads, and solder.



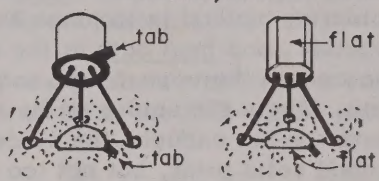
REGULAR CAPACITOR MOUNTING – ceramic, mica, electrolytic

Insert the capacitor as shown, bend leads, and solder. Make sure the electrolytic capacitors are installed with the positive (+) or negative (-) side going into the proper holes.



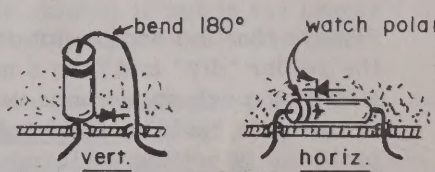
TRANSISTOR MOUNTING

Locate the proper transistor for the position on the board. Orient the transistor as shown and insert the leads into the corresponding holes. Bend leads, and solder.



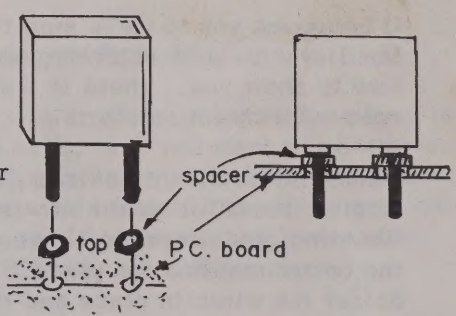
DIODE MOUNTING, VERTICAL and HORIZONTAL

These are mounted the same way as the vertical and horizontal mounts for resistors and capacitors. Pay careful attention to polarity. Make sure the end of the diode with a + or colored band(s) correspond to the cathode end of the diode marking on the parts layout. Bend leads and solder.



CRYSTAL MOUNTING

Place a small black spacer (supplied) over each of the two leads of the crystal and put its leads through the proper holes in the board. The recommended way of soldering these is to first "tack" solder one lead in place. This will hold the crystal firm while you solder the other lead. Then re-solder the "tack" soldered lead.



TWS-10

GENERAL ASSEMBLY INSTRUCTIONS

1. Read the instructions through carefully before assembly.

2. Inspect the circuit board for possible solder bridges or broken tracks. The boards come pre-tinned (solder tinned), so cleaning is usually not necessary.

3. Familiarize yourself with the various types of components and know their values. Check to make sure all components are included in the kit, and that they are of the proper value. If there were any changes made in parts numbers or values by HUFCO, they will be noted in the parts list and/or this text. Refer to the circuit board or parts layout diagram to find where each part goes.

4. Use only the solder supplied in the kit, or equivalent 60/40 rosin core solder. The use of fluxes and acid core or other solders will void the warrantee, and probably mess up your work. Use a low wattage (25-30 watt) soldering iron. Anything hotter will destroy the copper lands on the PC board.

5. If you are new at soldering, practice a few times before you start. Correct soldering method is to place the two wires, or other metal parts to be joined, together, and heat both at the same time. On a circuit board, rest the tip of the iron on the copper land and the wire coming through the board, and heat both. Apply the solder to the heated metal parts, not the iron tip. When the parts are hot enough, the solder will flow evenly. Use enough solder to make a good solid joint, but not too much.

   Remove the iron and do not disturb the joint for 3-10 seconds. This will let the solder "dry" and form a good electrical joint. It should appear shiny. A dull or rough appearance usually indicates that something got moved and the joint is "cold". Cold solder joints are a menace and the chief cause of problems in getting a kit to work. These must be re-heated, and sometimes solder must be added.

   It behooves you to make sure the soldering is done right. If you are not familiar with good soldering technique, then practice or get a friend who knows how to show you. There is a minimum charge of $5.00 on all returned kits with cold solder joint problems.

   Once you install a transistor, resistor, capacitor, diode, or other part with flexible leads, it would be wise to bend its leads (as shown on the component mounting guidelines) to between a 30° and 45° angle with the board to hold the component body in place. This reduces the chances for cold solder joints. Solder the wires in place and clip the leads to about 1/16" - 1/8" in length.

DIGI-DIAL ADAPTOR ASSEMBLY

6. ALL COMPONENTS, with the exception of switch S1, are installed from the top (component) side of the board.

7. Install all resistors. Resistors R8, R9, R13, R14 are installed vertically (vertical mount). All others are installed horizontally. Solder all resistors. Note: The 150 ohm resistors may be pre-bent. Also, R5 is not used unless called for in the parts list.

8. Install all capacitors. C11 and C13 have been changed to 120 pf. Install one of the 120 pf capacitors in either of the C11 positions. Install the other in either of the C13 positions.

   C7, C8, and C10 are mounted vertically. Bend leads and solder all capacitors in place.

   Make sure C15 is in with proper polarity. Note: If you are building this unit to fit in the TWS-6/600 cabinet, then do not install C15.

9. Install D1 and D2 vertically. Be sure they are in place with correct polarity. Solder. Note: If you are building this unit to fit in the TWS-6/600 cabinet, then do not install D1 and D2.

10. Install all coils. Be sure L2 (yellow, orange, black) is put in the proper place. Solder all coils in place. (Do not bend leads before soldering).

11. Install all transistors. Be sure that the tab on the transistors corresponds to the tab marking on the PC board. If the transistor has no tab, but has a flat section on the body, make sure it corresponds to the outline on the PC board. Q4 must also be oriented so that its tab corresponds to the marking on the board. Solder all transistors in place.

12. Install the crystal. (See component mounting guidelines).

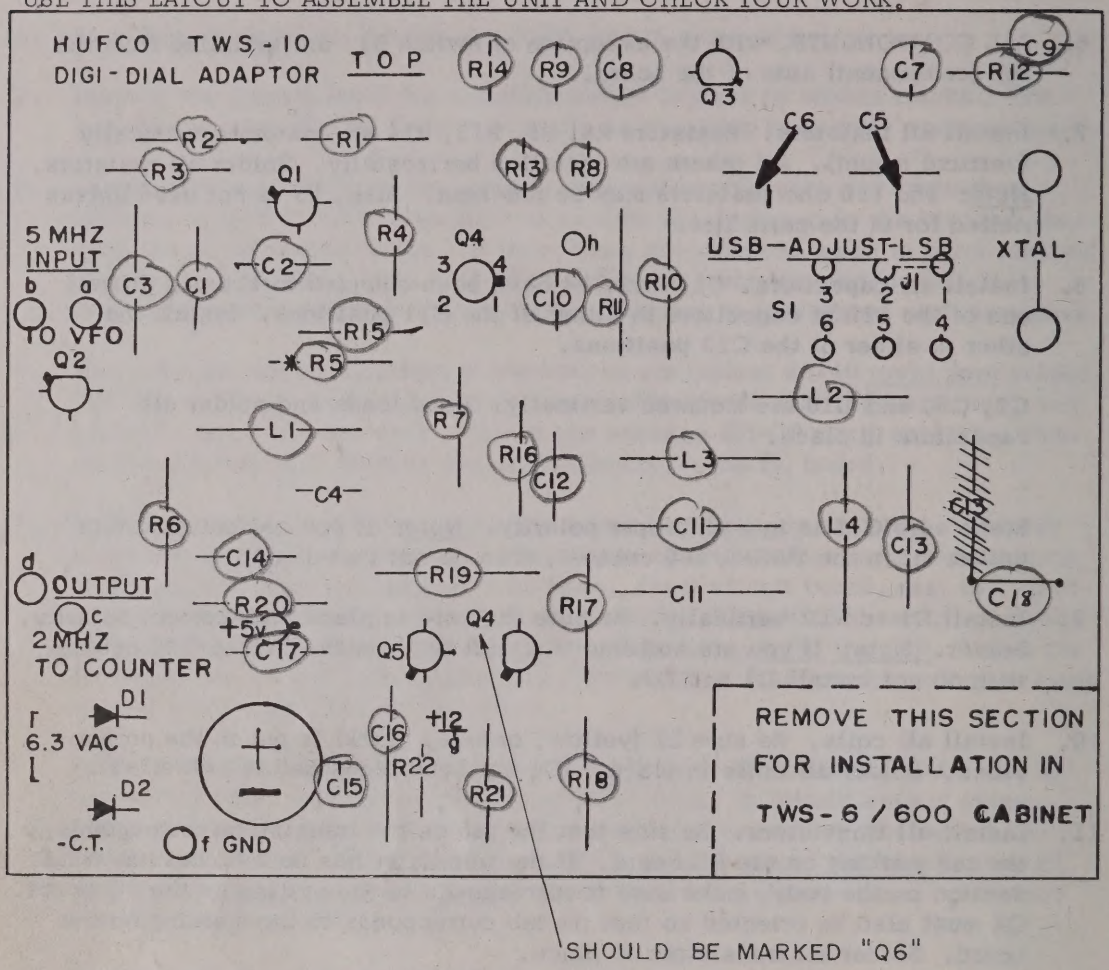
13. If you own a Heathkit or other transceiver with a VFO that shifts frequency to compensate for upper and lower side-band shift, or if you want to monitor the CW (center frequency) mode of the transceiver only, then follow 13(a) below. If you own a Kenwood, or other transceiver with a non-shifting VFO, and you want to monitor the actual transmit frequency of both upper and lower side bands, then follow 13(b). See "VFO SECTION" for more information.

    13(a) Heathkit (or equivalent) Owners:
    Install jumper J1 in holes 1 and 2 of the switch S1. Solder in place. Do not install the switch. Capacitor C6 is also not needed, but may be installed.

    13(b) Kenwood (or equivalent Owners:)
    Install the switch from the bottom (foil) side of the board. Solder holes 1 - 5. Soldering here is somewhat tricky but can be done with a relatively thin soldering tip.

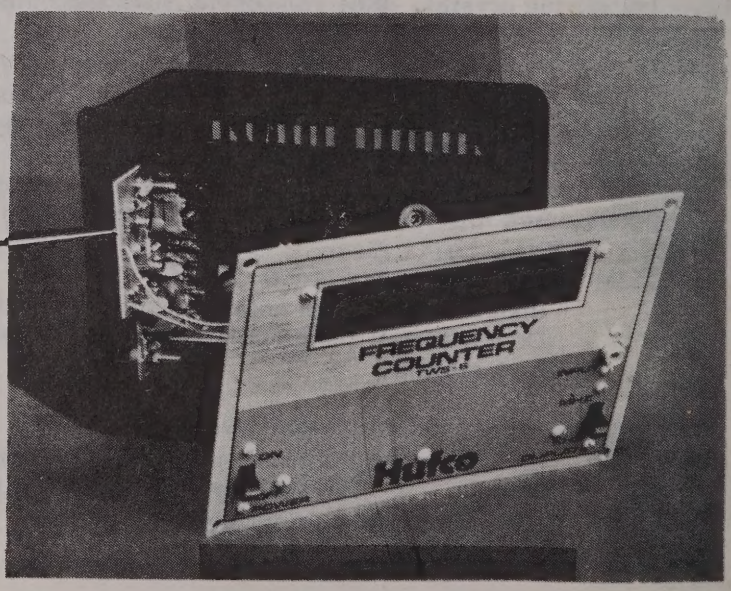
DIGI-DIAL ADAPTOR PARTS LAYOUT

USE THIS LAYOUT TO ASSEMBLE THE UNIT AND CHECK YOUR WORK.



SHOULD BE MARKED "Q6"

PLACEMENT OF DIGI-DIAL ADAPTOR IN TWS 6/600 CABINET



VFO SECTION

Heathkit VFOs switch frequency when you switch from upper to lower side band, to compensate for the inherent 1.5 kc frequency shift in the transceiver. When the instruction 13(a) is used, J1 is installed and the oscillator will be as shown in the Modified oscillator schematic, rather than the one shown in the schematic for the Digi-Dial Adaptor. This oscillator is tuned to 7.5000 mHz (via C5).

Kenwood and other similar transceivers do not compensate for this shift. Therefore, the oscillator in the Adaptor must. This is accomplished with a switch (S1) which selects frequencies at approximately 1.5 kHz around 7.5 mHz. For example, USB $\approx$ 7.4850 mHz; LSB $\approx$ 7.5015 mHz. The actual frequency shift is compensated for by tuning C5 and C6 to the proper values (See "TUNE-UP" section).

To check your transceiver to see which type it is, simply connect your counter to its VFO output. Switch the MODE switch from USB to LSB and back. If the counter shows a different frequency for each position ($\approx$3.0 kHz difference) then it compensates for the frequency shift and you should follow just 13(a). If there is not a detectable difference, then the transceiver does not compensate for the shift, and you should follow assembly instruction 13(b).

HOOK-UP-----DIGI-DIAL ADAPTOR

Your best bet is to use some kind of shielded cable to connect the adaptor to your counter and transceiver. The output of the adaptor is taken from holes "C" and "D" on the board. Run the shield to hole "D", and center conductor to hole "C". Connect the other end to the counter input. For TWS-6/600 owners, see TWS-6/600 Hook-up. (See Figures 1 and 3).

The output of the VFO of your transceiver (see chart below) goes to holes "A" and "B", the adaptor input. Use hole "B" for the shield, and hole "A" for the center conductor.

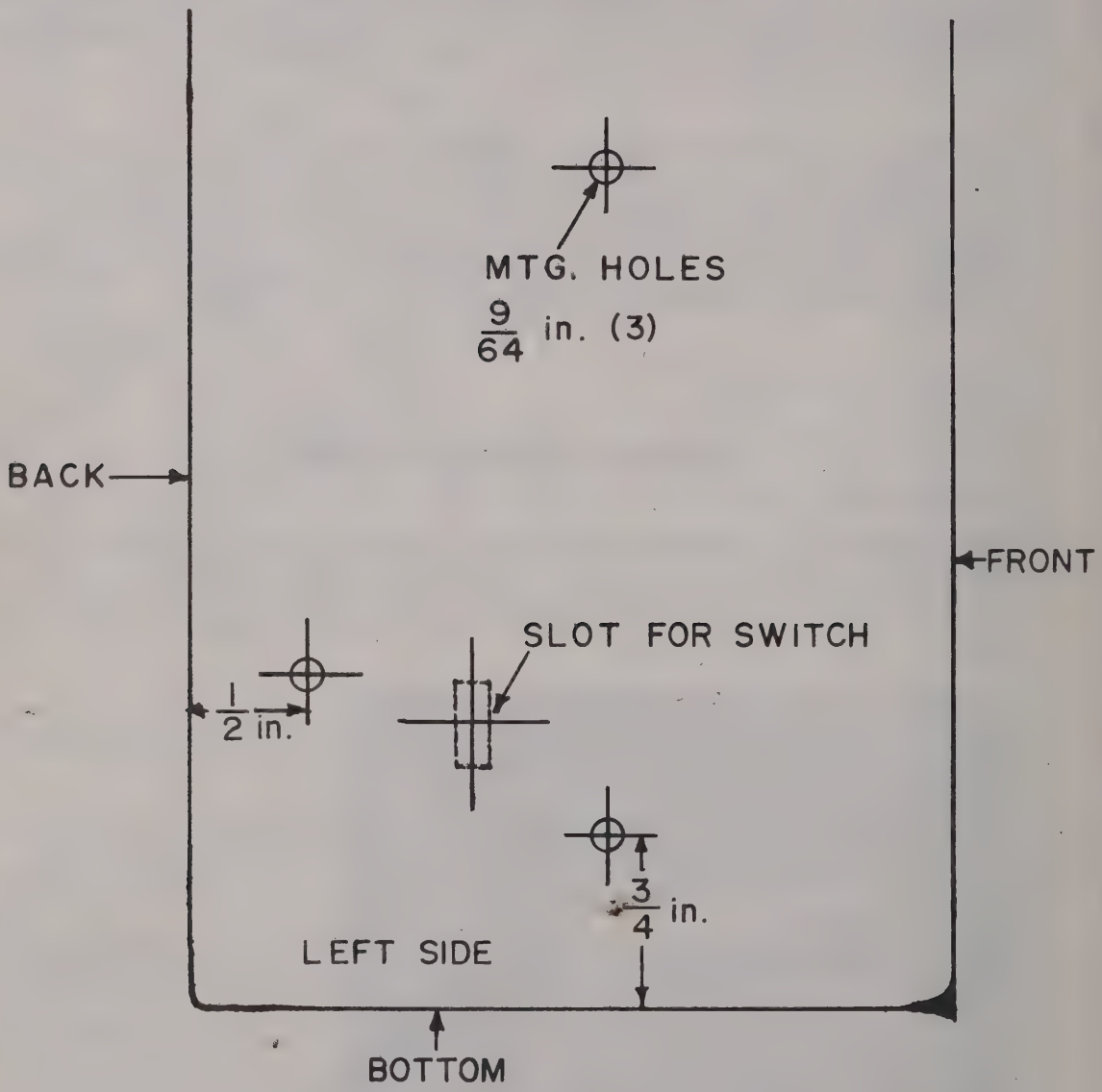
Power can be supplied any one of the following ways: If you have a 5 volt supply, you can run it to holes E(+) and F(-); 12 volt can be supplied to holes G(+) and F(-).

The adaptor also has its own DC rectification and filtering system. Any 6.3 volt C.T. transformer will do the job. Connect it to the appropriate places on the board.

NOTE: If you plan to run the Adaptor from 12 volts, take capacitor C15 out of the circuit and use a regulated 12 volt supply. The Adaptor is "touchy" about its power requirements in this configuration, and will probably require a regulated supply. Running it off of 5 v ($\pm$ .5v) or a transformer through its own rectification system seems to work best. (See Figure 2 for hook-up information).

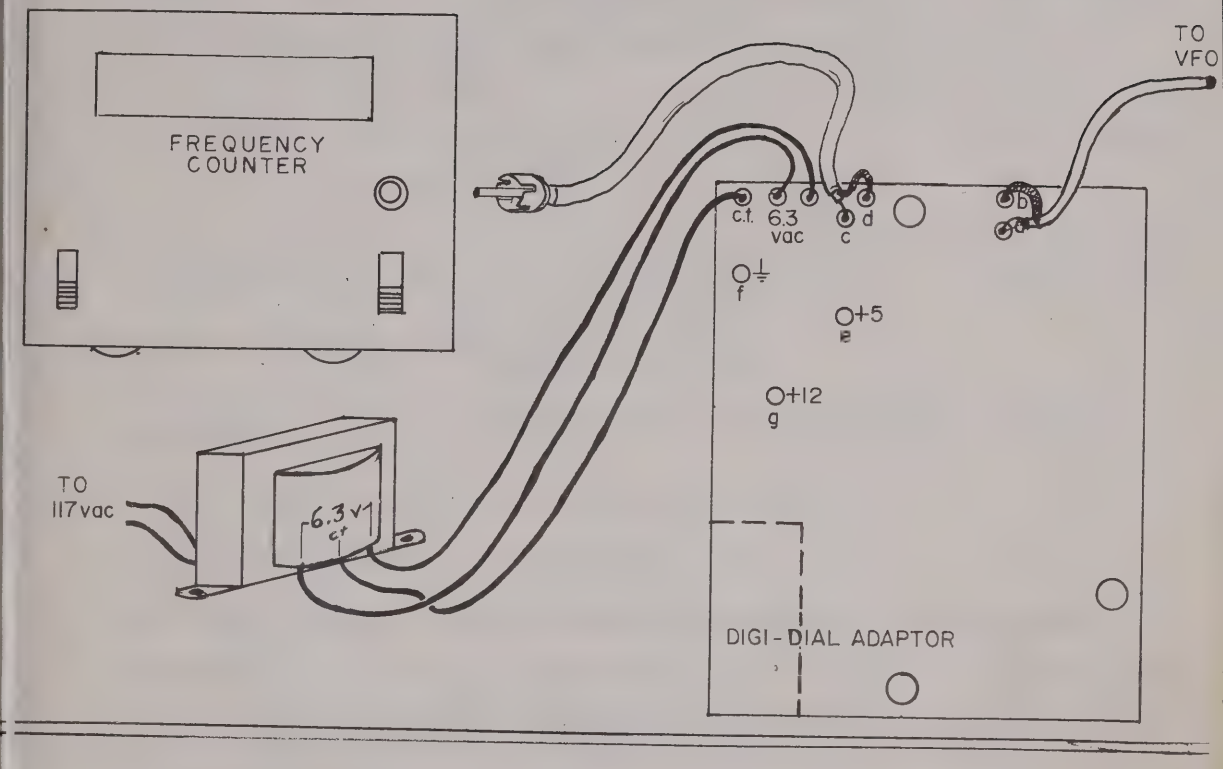
FIGURE 1

TEMPLATE (ACTUAL SIZE) FOR MOUNTING DIGI-DIAL ADAPTOR IN TWS-6/600 CABINET.



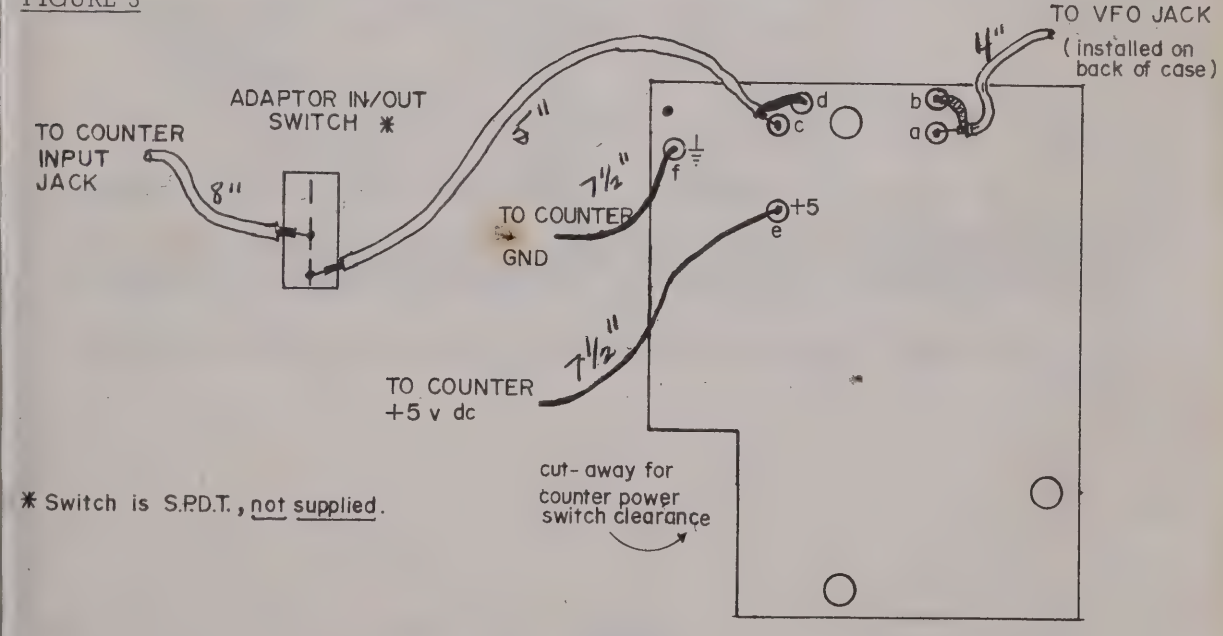
GENERAL HOOK-UP PROCEDURE

FIGURE 2



TWS-6/600 HOOK-UP PROCEDURE
(RECOMMENDED)

FIGURE 3



* Switch is S.P.D.T., not supplied.

CHART --- EXTERNAL VFO HOOK-UP

TRANSCEIVER Make & Model	How To Connect The Adaptor	External VFO Connector
Kenwood TS-520	Jumper pins 8 and 9 Connect Adaptor to pins 1 (input) and 2 (ground)	9 pin miniature
Tempo 1	Connect Adaptor to pin 3 (input) and 2 (ground)	7 pin
Yaesu FT Series	Jumper pins 1 and 8 Connect Adaptor to pins 6 (input) and junction of pins 1 and 8 (ground)	8 pin plug
Heath HW-104	Connect the Adaptor to the jumper (input) and a suitable chassis ground on the back of the set	wire jumper
Drake TR-3	Connect the Adaptor to pins 6 (input) and 8 (ground)	8 pin rectangular connector (#RV-3)

General rule for hooking up the Adaptor to any transceiver with a 5-5.5 mHz reverse-tuning VFO are as follows:

1) Locate the VFO output. Usually, this is the same as the external VFO input. On Heathkit models other than the HW-104, you'll have to go inside the transceiver.

2) Connect the Adaptor input to the VFO output and the shield to a suitable chassis ground.

TUNE-UP

A) Heathkit (or equivalent) Owners--

If you own a Heathkit, or followed assembly instruction 13(a), then do the following:

1) Connect the counter input to holes "h" (oscillator output) and "d" (ground) of the adaptor.

2) Turn on both units.

3) Adjust C5 until the counter reads 7500.0 kHz

4) Reconnect the adaptor as explained in "HOOK-UP".

B) Kenwood (or equivalent) Owners--

If you own a Kenwood, or followed assembly instruction 13(b), then do the following:

1) Connect the adaptor as explained in "HOOK-UP".

2) Turn on adaptor, transceiver and counter.

3) Put VFO mode switch on transceiver to INTERNAL. Operate mode to LSB.

4) Use the internal 25 kHz marker or other accurate device to audibly zero the transceiver on a known frequency; ie., 7.2500 mHz.

5) Switch S1 on adaptor to LSB (position nearest to the crystal). In the TWS-6/600 cabinet, the switch would be in the DOWN position.

6) Tune C5 until the counter reads 2.2500 mHz.

7) Repeat the procedure with the transceiver in USB position by again zeroing in on the same frequency (7.2500 mHz). Switch S1 the other way (position farthest from the crystal) - UP for TWS-6/600, and tune C6 until the counter reads 2.2500 mHz.

8) Tuning is now complete. By ignoring the first "2", you now have an accurate digital readout of all the kHz positions, right down to 100 Hz!

TROUBLE-SHOOTING

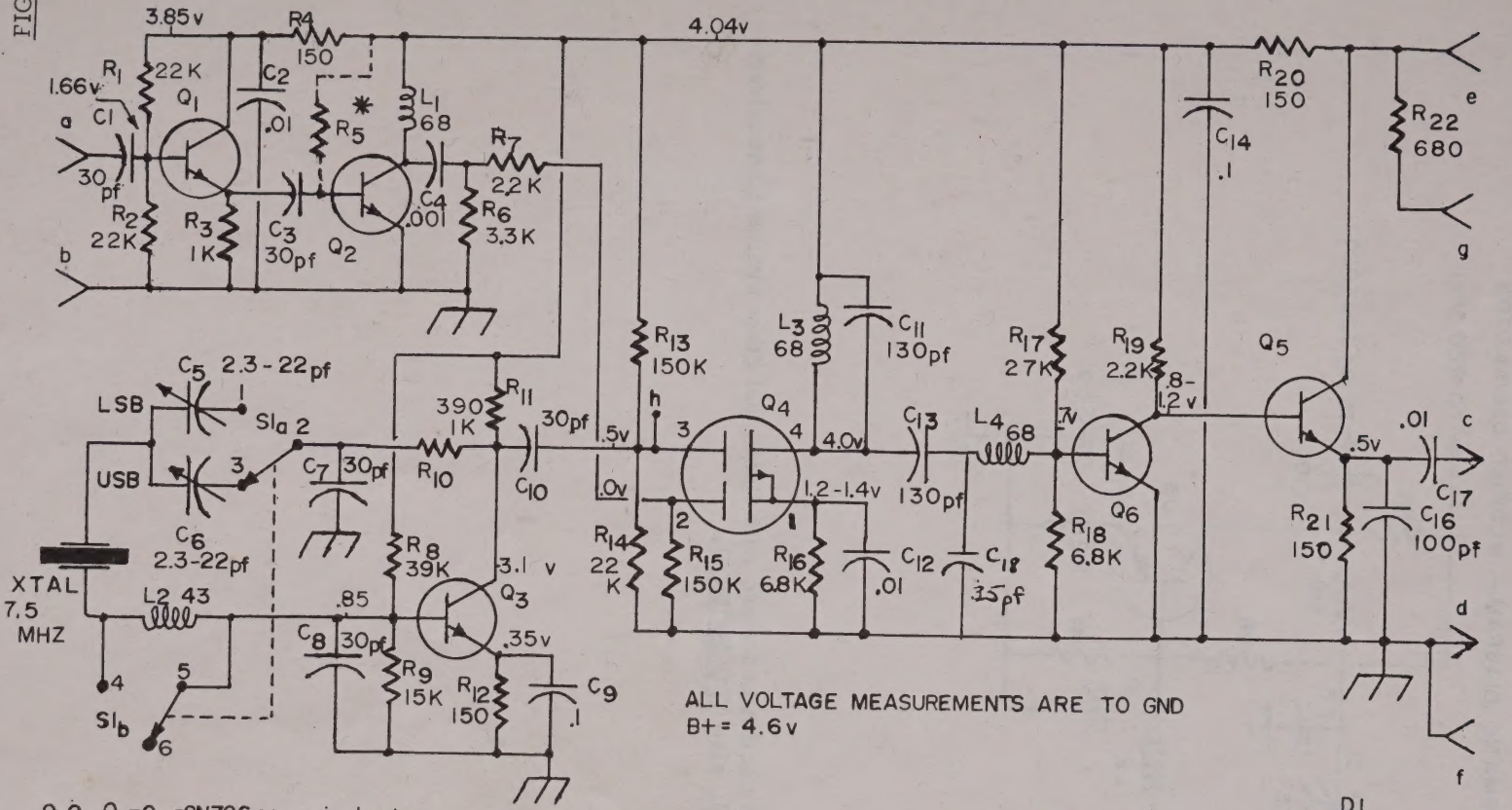
Since this is a relatively new product, we do not have any reasonable service record available. This chart, however, should provide some help in solving your particular problem, should you have any. At any rate, we can fix the unit should you not be able to locate the specific problem with it.

IN ANY EVENT OF TROUBLE, SAVE YOURSELF SOME MONEY. Check for solder bridges, cold solder joints, and make sure all parts are in the right places.

PROBLEM	CHECK
No Output	Make sure you have an input to the adaptor-ie; 5 mHz VFO from the transceiver. Note: The transverter output will not work. If there is no VFO input, the mixer will not put out anything. Check power to the adaptor--make sure it's within specified range. (5v ± .5v) Check at hole "h" for 7.5 mHz waveform. Check all voltage levels for the proper values (proportionate to the B+ voltage you are using).
No 7.5 mHz Oscillation	Check L2--make sure it's a 43 uh unit (yellow, orange, black). Adjust C5 or C6. Oscillator may not oscillate if these are at full open (minimum value) position.

SCHEMATIC DIAGRAM DIGI-DIAL ADAPTOR TWS-10 HUFCO

FIGURE 4



Q_1-Q_3, Q_5-Q_6 = 2N706 or equivalent

Q_4 = 40673

D_1, D_2 = 1N4004 or equivalent

All resistances are in Ω.

All capacitances are in μf, unless otherwise specified.

All inductances are in μh.

* R_5 may or may not be included. See instructions.

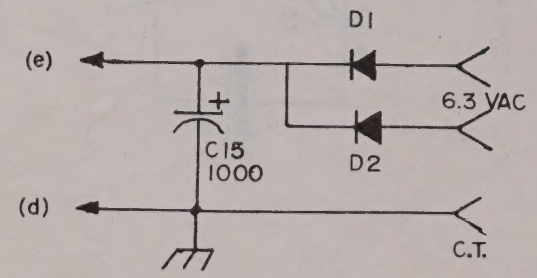


FIGURE 5

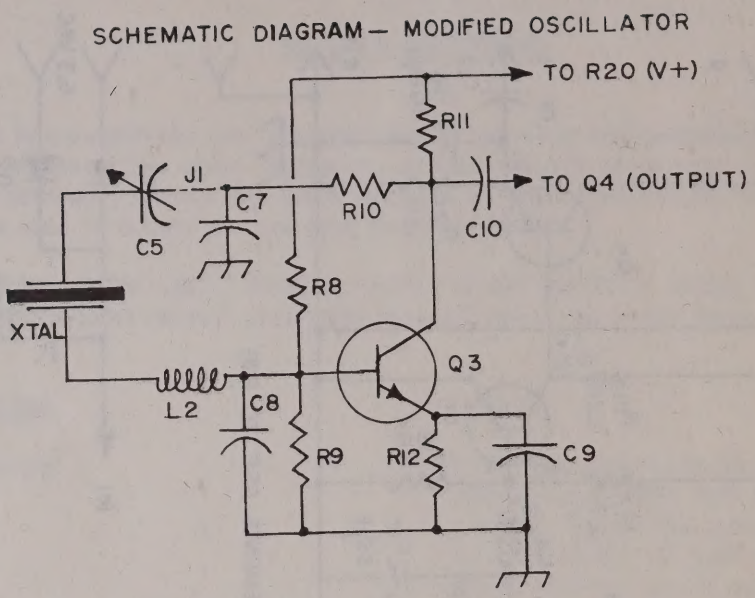


Figure 5: Modified oscillator for use with Heath and other similar transceivers--see HOW IT WORKS, also VFO SECTION.